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1. Introduction

The Microgrids are designed to provide AC power at sites that are not connected to the grid (off-grid) and to provide energy security for grid-connected sites that experience frequent outages e.g. loadshedding.

2. Supporting Clauses

2.1 Scope

2.1.1 Purpose

This document details the technical requirements for the major equipment that are integrated to form the Microgrid system for residential and commercial applications.

2.1.2 Applicability

This document shall apply to the PV-BESS Microgrid Systems used in the Distribution Division of Eskom.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001, Quality Management Systems

[2] 240-75655504 Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, Components, Materials and Structures Manufactured from Steel Standard

[3] 240-108982466 Standard for HV Yard Stones in Eskom Substations

[4] 240-126910106 Particular requirements for Eskom smart metering system

[5] 240-170000189 Standard for current and future metering implementation

[6] 240-170000943 Microgrids Planning Standard

[7] 240-52840736 Specification for a programmable three phase meter

[8] 240-75659760 Pole-mounted service distribution boxes for split prepayment metering

[9] 240-76368574 High Security Mesh Fencing Standard

[10] 240-76628293 Standard for energy meter kiosks: Low-voltage for 100kVA small power users (SPU) & large power users (LPU)

[11] 240-76628297 Standard for energy meter kiosks: Ground mounted, low-voltage 100kVA to 1 MVA, for large power users (LPU)

[12] 240-78980848 Specification for Nonlethal Energized Perimeter Detection System (NLEPDS) For Protection of Eskom Installations and Its Subsidiaries

[13] 240-82172806 Standard for Air Conditioning in Transmission Substation Buildings and Telecommunication Sites.

[14] 240-91190304 Specification for CCTV Surveillance with Intruder Detections

[15] 240-102220945 Specification for Integrated Access Control System (IACS) for Eskom Sites

[16] 240-132190480 Telecommunications Equipment Installation Standard

[17] 240-153473135 Installation of Telecommunications Equipment Cabinet

[18] 240-54615374 Distribution Substation Gateway Specification

[19] 240-103792430 Telecoms Cables and Various Materials Specification

[20] 240-95399670 Telecommunications Network Interface Converters Standard

[21] 240-75975613 Standard for the Installation of Power Telecommunication Equipment

[22] 240-72274830 Multimode Fibre Optic Duct Cable Specification

[23] 240-70783066 Telecommunications Transport Network Standard for TDM Circuits

[24] 240-70732888 Fibre Optic Cable System Acceptance Testing

[25] 240-48584707 Operational Technologies Over IP/MPLS

[26] 240-46264031 Fibre-Optic Design & Installations – Substations

[27] 240-170000193, Stationary Lithium Iron Phosphate batteries

[28] D-DT-1023, Manufacturing design drawings for 100-500kVA wall mount LPU kiosk

[29] D-DT-1042, Manufacturing design drawings for pole top 2-way kiosk

[30] D-DT-1043, Manufacturing design drawings for pole top 4-way kiosk

[31] D-DT-1044, Manufacturing design drawings for pole top 6-way kiosk

[32] D-DT-1045, Manufacturing design drawings for pole top 8-way kiosk

[33] D-DT-1046, Manufacturing design drawings for 100kVA meter and data concentrator kiosk

[34] D-DT-1047, Manufacturing design drawings for 50kVA meter and data concentrator kiosk

[35] D-DT-4407 sheet 1D, Micro Grid System (MGS), 6m container and solar panel structure, earthing details

[36] D-DT-5237 sheets 7 A-I, Security Fence, 2.4m steel palisade fence

[37] D-DT-5240 sheet 6, Earthing Standard, typical equipment foundation detail

[38] D-DT-5254 sheet 2C, Substation stone kerbing

[39] D-DT-5282, Steel Container, for micro grid system foundation details

[40] Grid Connection Code for Battery Energy Storage Facilities (BESF) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa, Version 5.3, March 2023

[41] IEC 60068 Environmental Testing, all parts

[42] IEC 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements

[43] IEC 60364-4-41:2005 Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock

[44] IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)

[45] IEC 60947 Low-voltage switchgear and controlgear

[46] IEC 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

[47] IEC 61215 Ed.2, Crystalline silicon terrestrial photovoltaic (PV) module - Design qualification and type approval

[48] IEC 61215-1:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements

[49] IEC 61215-2:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures

[50] IEC 61326-1:2020 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

[51] IEC 61730-1:2016 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction.

[52] IEC 61730-2:2016 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing.

[53] IEC 62109-1:2010 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements

[54] IEC 62109-2:2011 Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters

[55] IEC 62619:2022 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications

[56] IEC 62852:2014 Connectors for DC-application in photovoltaic systems - Safety requirements and tests

[57] IEC 63056:2020 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems

[58] NRS 081 Single-Mode Non-Dispersion Shifted Optical Fibres

[59] NRS 088-1 Duct and Direct Buried Underground Fibre Optic Cable Part 1: Product Specification

[60] NRS 088-2 Duct and Direct Buried Underground Fibre Optic Cable Part 2: Installation Guidelines

[61] NRS 097-2-1:2017 Small-scale Embedded Generation, Utility Interface

[62] SANS 10139 Code of practice for design, installation, commissioning and maintenance of fire detection and alarm systems in non-domestic premises.

[63] SANS 10160 General Procedures and Loadings to be Adopted in the Design of Structures

[64] SANS 14520 Gaseous Fire Extinguishing Systems – Physical Properties & System Design

[65] SANS 15779 Condensed Aerosol fire extinguishing systems – General Requirements

[66] SANS 10142-1 - The wiring of premises Part 1: Low-voltage installations.

[67] SANS 121:2011 Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

[68] SANS 657:2011 Steel tubes for non-pressure purposes.

[69] SANS 1200 C, Standardized specification for civil engineering construction Section C: Site clearance

[70] SANS 1200 DA, Standardized specification for civil engineering construction Section DA: Earthworks (small works)

[71] SANS 60269-1, Low-voltage fuses Part 1: General requirements and

[72] SANS 60269-6:2021, Low-voltage fuses Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems.

[73] SANS 61000-6-2, 3 and 4: Electromagnetic compatibility (EMC)

[74] SANS 61140 Protection against electric shock – Common aspects for installation and equipment

[75] SANS 61204 Low-voltage switch mode power supplies

[76] UL 1741: 2021 Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

[77] SANS 62305 Protection against lightning

[78] SANS 62930 Electric cables for photovoltaic systems with a voltage rating of 1,5kV DC.

[79] SANS 60755-1 Residual current operated protective devices for DC systems.

[80] IEEE 1547:2018 Standard for Interconnecting Distributed Resources with Electric Power Systems

[81] IEEE 1815 Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3)

[82] IEEE 2030.5 Standard for Smart Energy Profile Application Protocol

[83] 32-373: Information Security – IT/OT and Third Party Remote Access Standard

[84] 240-64038621, Remote Device Communication Standard to Data Retrieval and Remote Access

[85] Grid Connection Code for Renewable Power Plants (RPPs) in South Africa, latest.

[86] 240-89498731, Equipment Container for AC-Powered Sites, latest.

[87] 240-171000459, Specification for BESS & Inverter Housing and Enclosure Structures

[88] SunSpec ModBus, https://sunspec.org/specifications/

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

None

2.3.2 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AC	Alternating Current
BESS	Battery Energy Storage System
BESF	Battery Energy Storage Facility
BMS	Battery Management System
CCTV	Close Circuit Television
c-Si	Crystalline silicon
DC	Direct Current
DER	Distributed Energy Resource
NVR	Network Video Recorder
Dx	Distribution
EMS	Energy Management System
HES	Head End System for smart meters
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
IACS	Integrated Access Control System
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

Abbreviation	Description
LPU	Large Power Users
I/O	Input Output
MCB	Main Circuit Breaker
NLEPDS	Nonlethal Energized Perimeter Detection System
NVR	Network Video Recorder
OEM	Original Equipment Manufacturer
PCC	Point of Common Coupling
PV	Photovoltaic
REA	Remote Engineering Access
RTU	Remote Terminal Unit
SANS	South African National Standard
SCADA	Supervisory, Control and Data Acquisition
SOC	State of Charge
SPU	Small Power Users
SSEG	Small Scale Embedded Generation
STC	Standard Test Conditions
UPS	Uninterruptible Power Supply
VMS	Video Management System

2.5 Roles and Responsibilities

The system design team shall ensure that the requirements of this standard are adhered during the design and equipment selection stages of the project.

2.6 Process for monitoring

Not applicable.

2.7 Related/Supporting Documents

This document supersedes 240-171000166, SSEG – Major Equipment requirements for Dx Solar PV and BES Systems.

3. Technical Requirements

3.1 General

3.1.1 In cases where standard, technically acceptable equipment is available on Contracts / Enabling Agreements, this equipment shall be used during system design.

3.1.2 The only exception to the above statement, is when the required equipment is not available on Contracts / Enabling Agreements, in which case the relevant standards (technical specifications) shall be used to procure the equipment.

3.1.3 The Microgrid solution shall ensure that all units that is to be interfaced to the SCADA gateway and the Remote Eng Solution has all the appropriate hardware interfaces required (i.e. RS485, Ethernet and others). If the hardware interfaces are serial, it shall comply with the 2kV isolation as per the relevant IEC specifications.

3.1.4 All equipment shall be environmentally rated for the locations they are installed at. Outdoor equipment shall at minimum be IP65 rated, and indoor equipment at minimum IP21 rated.

3.1.5 All outdoor equipment and consumables shall be suitably rated for exposure to UV rays and highly corrosive conditions (e.g. rated / protected against rust). Where required, equipment shall be located to maximise protection against such elements and may necessitate dedicated covers. The tenderer shall demonstrate that the equipment meets this requirement by indicating the relevant technical standard supporting this.

3.1.6 OEM recommended design guidelines shall be followed wherever possible. Where such recommendations are required by any statutory requirement, it shall be implemented.

3.1.7 All regulatory requirements shall take precedence over any specific requirements specified here within. Furthermore, for any contradicting requirements, for which this document is the stricter, this document shall take precedence.

3.1.8 The integration of all plant subsystems shall comply with all applicable regulatory and legal requirements.

3.1.9 The plant will be operated and maintained in-line with OEM recommendations and legal requirements.

3.1.10 Valid type test certificates and type test reports shall be provided where applicable.

3.2 System Description

The equipment will be installed in a housing of varying dimensions which are dependent on the spacing requirements based on OEM recommendations, equipment form factors and safety requirements. The housing can be a shipping container, a purpose-built container, a building (brick-and-mortar) or other enclosure that meets the functional requirements and relevant Eskom standard or industry best practice.

The major equipment includes the following:

a) Hybrid Inverters

b) Battery banks (Energy Storage System)

c) Solar Panels

d) SCADA System

e) AC Distribution Board

f) DC Distribution Board

g) HVAC system

h) Physical Security System

i) Fire Detection and Suppression System

j) Telecommunications system

3.3 Inverters

3.3.1 Grid Compliance & Safety Standards

The inverter shall comply with the requirements of the following technical standards (latest revisions):

3.3.1.1 [53] SANS/IEC 62109-1, Safety of power converters for use in photovoltaic power systems – Part 1: General Requirements.

3.3.1.2 [54] SANS/IEC 62109-2, Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters.

3.3.1.3 [61] NRS 097-2-1, Grid Interconnection of Embedded Generation – Part 2: Small-scale Embedded Generation – Section 1: Utility Interface.

3.3.1.4 Inverters shall be equipped with volt-var control and frequency control modes in addition to the normal category A Grid Code requirements ([40] Grid Connection Code for Battery Energy Storage Facilities (BESF) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa, Version 5.3, March 2023).

3.3.2 Electrical & Performance Requirements

3.3.2.1 The inverters shall be of the hybrid type (bi-directional) that are able to accept power from various power sources (i.e. PV panels, wind generators, batteries, standby generators and the grid) and optimally manage the energy from these power sources to ensure a reliable AC supply to the connected loads.

3.3.2.2 Hybrid inverters shall exclusively be used in the solution, utilising a single internal DC bus and single DC to AC inverter step.

3.3.2.3 Only inverters producing pure sine waves shall be used.

3.3.2.4 The inverter shall be able to function as an off-grid (grid forming) inverter or a grid-tied (grid-following) inverter dependent on the application.

3.3.2.5 The inverters shall be able to operate in parallel and share the load currents equally.

3.3.2.6 The inverters shall be single-phase or three-phase.

3.3.2.7 The output voltages shall comply with requirements as stipulated in [62] SANS 10142-1 - The wiring of premises Part 1: Low-voltage installations.

a) 230V ± 10% for single-phase systems,

b) 230/400V ± 10% for three-phase four-wire systems.

c) Nominal frequency tolerance of 50Hz with ±2%.

3.3.2.8 The weighted average efficiency (Euro, CEC, or similar) shall be 96% or higher.

3.3.2.9 THD (Total Harmonic Distortion) of ≤3% at full load.

3.3.2.10 Hybrid inverters shall be rated for a 5 second, 20% overload power output above nominal rated output.

3.3.2.11 All inverters shall include a measurement element(s) (e.g., CT(s)) positioned at the PUC or another suitable location, to enable the inclusion of non-essential loads in the export management strategy.

3.3.2.12 Inverters that are designed as single-phase units shall be able to be configured to operate as a three-phase, multi-unit system.

3.3.2.13 Inverter systems shall include their own built-in control and protection systems.

3.3.3 Protection Features

3.3.3.1 Support overvoltage protection.

3.3.3.2 Support undervoltage protection.

3.3.3.3 Support overcurrent protection.

3.3.3.4 Support short circuit protection.

3.3.3.5 Support over-temperature shutdown with automatic recovery.

3.3.4 PV Input & MPPT Requirements

3.3.4.1 Individual PV string level monitoring will be provided by the system.

3.3.4.2 Each PV input terminal shall have an independent MPPT.

3.3.4.3 DC/AC Ratio of at least 1.3, for oversizing capability.

3.3.4.4 MPPT Efficiency of at least ≥99%.

3.3.5 Paralleling Requirements

3.3.5.1 Inverters shall support synchronised AC paralleling, enabling multiple units (at least 5x) to share loads while maintaining proper phase and frequency control.

3.3.5.2 Hybrid inverters must support parallel operation on a shared DC bus, allowing multiple units to charge and discharge a common battery bank efficiently.

3.3.5.3 Paralleled inverters must dynamically share power output and battery charging/discharging loads to ensure balanced operation and system scalability.

3.3.6 Unbalanced Load Support

3.3.7 Hybrid three phase inverters or single-phase inverters, configure as three-phase system, shall support 100% unbalanced loads. This means they must be capable of independently supplying different power levels to each phase without requiring a balanced three-phase load distribution.

3.3.8 The system shall ensure stable operation even if one or more phases experience significantly higher or lower load demand.

3.3.9 Human Machine Interface (HMI)

3.3.9.1 The inverter shall have a user friendly, access controlled, Human-Machine Interface (HMI) that allows the user to read inverter real-time operational parameters, read settings, configure setpoints and control the inverter based on the user's level of access.

3.3.9.2 The HMI shall indicate the system status and raise local warnings and alarms visually and audibly.

3.3.9.3 The HMI may be available per inverter or shared between a bank of inverters.

3.3.10 Communications & Monitoring

Inverters shall support communication to external data-loggers or local/remote gateways using the protocols and interfaces specified in section 3.7 of this document.

3.3.11 Backup & Off-Grid Functionality [Hybrid inverters only]

3.3.11.1 Shall support seamless switching (≤20ms) between grid, battery, and PV for essential loads.

3.3.11.2 Capable of black start operation (starting up without grid power).

3.3.11.3 Must support generator input integration, capable of accepting the inverter's full rated continuous power output, with an auto start function (signalling).

3.3.11.4 Must support generator input integration, capable of accepting the inverter's full rated continuous power output, with an auto start function (signalling).

3.3.11.5 The generator input shall support the charging of batteries.

3.3.11.6 Ability to operate in grid-tied, off-grid, and hybrid mode.

3.3.11.7 Support a relay output (dry or wet) capable of driving a 230VAC relay/contactor coil to enable temporary neutral-earth bond to be created during AC supply loss conditions. Also referred to as an Automatic Transfer Switch (ATS).

3.3.12 Battery Compatibility & DC Bus [Hybrid inverters only]

3.3.12.1 Must support 48V or high-voltage battery banks.

3.3.12.2 Compatible with Lithium-Ion and specifically Lithium-iron-phosphate (LFP) battery chemistry.

3.3.12.3 Support BMS communication via CAN & Modbus to the batteries offered.

3.3.13 Environmental Ratings & Installation

3.3.13.1 Support at minimum an IP65 rating for all Hybrid inverters.

3.3.13.2 At minimum an IP65 rating for all String inverters.

3.3.13.3 Support outdoor installation.

3.3.13.4 Support a wide operating temperature range of -10°C to 55°C with derating only applicable beyond 45°C.

3.3.13.5 Support both wall-mountable and floor-standing.

3.4 PV Panels

3.4.1 Crystalline silicon (c-Si) based PV modules shall be used.

3.4.2 The specified usable peak output power is applicable at the start of operations, post commissioning and handover.

3.4.3 To ensure efficient use of space, module efficiencies shall be at least 19% at a Standard Test Condition (STC) of irradiance 1000 W/m^2, spectrum AM 1.5 and cell temperature of 25°C.

3.4.4 For each 18 to 24 cells within a module, a bypass diode shall be implemented.

3.4.5 Within the first year, the actual output power of PV modules shall be within 3% of its rated capacity.

3.4.6 Modules shall not decline in output power by more than 0.8% per year from year 2 to 20, this shall be warranted by the OEM.

3.4.7 The PV panels shall comply with the requirements of the following technical standards:

a) [47] IEC 61215 Ed.2, Crystalline silicon terrestrial photovoltaic (PV) module - Design qualification and type approval.

b) [51] IEC 61730-1 Ed.1.2, Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction.

c) [52] IEC 61730-2 Ed.1.0, Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing.

d) Minimal safety class II according to [43] IEC 60364-4-41:2005+AMD1:2017, [74] SANS 61140 & [75] SANS 61204.

e) The integrated PV panel cable connectors shall meet or exceed a rating IP67 rating as defined in [44] IEC 60529 and fulfil the safety requirements and tests of [56] IEC 62852.

3.4.8 PV modules independent PID testing, and verification tests should be performed, and results provided in accordance with [47] SANS 61215:2015 and [51] SANS 61730-1.

3.5 Battery System

3.5.1 Batteries will be subjected to daily cycling, barring less favourable weather conditions.

3.5.2 Cycling shall include micro-cycles, as demand and supply fluctuate from time to time.

3.5.3 Batteries shall support at least 5000 cycles until it reaches 80% of its original (full and usable) capacity. The usable capacity at this (end) cycle-life shall be specified.

3.5.4 An always online cell-balancing mechanism shall be available to ensure the battery's capacity is not compromised by an imbalance. No manual intervention should be required to balance the cells.

3.5.5 The storage solution shall be able to restart and continue normal operations following a complete discharge of all useable capacity, without any manual intervention. Therefore no "activation" of fully discharge batteries will be required.

3.5.6 The BESS shall support momentary over-current conditions, as example due to inrush currents from large, switched load equipment. At minimum a 10% overload for 1 minute will be supported. Both batteries (or their configuration) and their inverters shall support this.

3.5.7 Batteries shall be stacked and / or housed in a suitable enclosure, depending on the location.

3.5.8 All statutory and other mandatory requirements regarding safety, such as fire protection systems; and electrical fire, safety, incident response and security protocols shall be strictly adhered to, and in no way compromised by the solution.

3.5.9 The battery BMS and Controllers shall support communication to external data-loggers using the protocols and interfaces specified in section 3.7 of this document.

3.5.10 The battery shall comply with the requirements of the following technical standards:

a) [27] 240-170000193, Stationary Lithium Iron Phosphate batteries

b) [55] SANS/IEC 62619:2022, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

c) [57] IEC 63056 Ed. 1.0 b:2020, Secondary Cells and Batteries Containing Alkaline Or Other Non-Acid Electrolytes - Safety Requirements For Secondary Lithium Cells And Batteries For Use In Electrical Energy Storage Systems.

3.6 AC and DC protective devices

3.6.1 AC and DC circuit breakers, contactors and switches shall comply with the relevant parts of [45] SANS 60947 series of standards. DC residual circuit breakers for PV installation shall comply with [79] SANS 60755-1

3.6.2 Fuse-links for the protection of solar Photovoltaic (PV) energy systems shall comply with all the requirements of [71] SANS 60269-1, Low-voltage fuses Part 1: General requirements and [72] SANS 60269-6:2021, Low-voltage fuses Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems.

3.6.3 The DC cables shall comply with [78] SANS 62930, Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC.

3.6.4 The DC connectors for the PV wires shall comply with [56] SANS 62852, Connectors for DC-application in photovoltaic systems - Safety requirements and tests.

3.7 Remote Monitoring and Control Requirements

3.7.1 The DER shall comply with [80] IEEE1547 remote monitoring and control requirements which are listed below.

3.7.2 All DERs shall be able to provide certain data points to the utility/operator via remote communications. These include:

a) Active power (kW) output (real power).

b) Reactive power (kVAR) output.

c) Apparent power (kVA).

d) Voltage (V) at the point of common coupling (PCC).

e) Current (A).

f) Frequency (Hz).

g) Status (online, offline, tripped, standby).

h) Alarm/Trip events (fault codes, abnormal conditions).

3.7.3 DERs shall support real-time or near-real-time telemetry. Resolution typically ≤1 second to a few seconds, depending on the application (frequency response vs. slow demand response).

3.7.4 The DER shall support industrially acceptable time-stamping and accuracy requirements applicable to the application supported.

3.7.5 For remote monitoring and control, the DER shall support the following non-proprietary protocols:

a) [82] IEEE 2030.5 (SEP2)

b) [88] SunSpec Modbus

c) [81] IEEE 1815 – 2012 Level 2 or higher (DNP3 serial/IP) - Only required for direct interface to the Distribution Management System (SCADA) at an Eskom Control Centre.

3.7.6 DERs shall remotely report:

a) DER availability (able/unable to generate or discharge).

b) Operating mode (e.g., constant power, Volt-VAR mode, frequency-watt control).

c) DER nameplate ratings (capacity).

d) State of charge (SOC) if storage is present.

e) Connectivity status (grid-connected, islanded, tripped).

3.7.7 Remote monitoring functions shall implement authentication and encryption to protect against unauthorised access.

3.7.8 With regards to cybersecurity guidelines for smart grid interoperability the DER shall support the requirements as per [80] IEEE 1547.

3.7.9 DERs shall allow for remote adjustment of real power output which includes the following functionality:

a) Limit maximum active power (e.g., cap export to avoid feeder overload). Active power setpoint control (send a kW target).

b) Ramp rate control (limit how fast power changes).

3.7.10 The DER shall support remote adjustment of reactive power (kVAR) which includes the following functionality.

a) Fixed power factor (e.g., 0.95 lagging).

b) Fixed kVAR setpoint.

c) Volt-VAR curve activation/deactivation.

d) Scheduled VARs (time-based settings).

3.7.11 **Voltage and Frequency Ride-Through Settings**: Utilities can remotely update the DER trip settings (within allowable ranges) for:

a) Over/under-voltage thresholds.

b) Over/under-frequency thresholds.

c) Ride-through durations (how long to stay connected before tripping).

3.7.12 **Operating Modes and Functions**: DERs shall allow enabling or disabling of different modes remotely. These modes include:

a) Constant power factor mode.

b) Volt-VAR control.

c) Frequency-Watt mode.

d) Volt-Watt mode.

3.7.13 The DER shall allow remote tripping/disconnect in the case of network emergencies.

3.7.14 DERs shall be able to follow time-based schedules sent remotely.

3.8 SCADA Gateway Requirements

Should the DER require the installation of a SCADA Gateway to enable remote communication to a utility Master Station (Control Centre), the SCADA Gateway shall comply with the requirements stipulated in this section.

3.8.1 A Gateway/Remote Terminal Unit (RTU) scheme shall be installed to enable data exchange between remote master stations (such as the regional SCADA control centres) and the DER solution.

3.8.2 Taking into consideration factors such as cost effectiveness, product lifecycle, functionality, the RTU selected shall be the Eskom Distribution approved gateways currently on contract. The Gateway/RTU selected from the Dx contract shall meet the I/O requirement of the DER solution.

3.8.3 The full Gateway/RTU scheme i.e., cabinets, MCBs, power supplies etc shall be installed for this solution. Note that all Eskom standardised equipment that is currently on contract shall be used to fulfil this functionality.

3.8.4 Should the SCADA Gateway/RTU solution require an ethernet network once again only Eskom standardised equipment and patch leads that is on contract shall be used to provide this functionality unless the design requires different equipment based on technical or cost requirements. A design and cost motivation to use different equipment and cables shall also be submitted as part of the Tender for Eskom's perusal. Thus, costing for this network solution shall be provided in the Tender for the following minimum scenarios namely:

a) With the use of Eskom's standardised equipment

b) With the Supplier's recommended equipment (if different) from Eskom's standard equipment.

3.8.5 The DER shall, therefore, allow for space for a wall mounted cabinet (600 x 400 x 800mm).

3.8.6 The DC supply of the SCADA Gateway/RTU shall be appropriately designed to interface to the DER DC supply.

3.8.7 The inputs and outputs to be interfaced to the RTU via hardwiring shall support the appropriate voltages accepted/provided by the SCADA Gateway/RTU scheme i.e.:

a) Digital Inputs – dry contacts shall be interfaced to the RTU (wetted by the RTU scheme by 48VDC supply)

b) Digital Outputs – The RTU provides 48VDC control outputs.

3.8.8 No proprietary protocols shall be supported for the interface between the RTU and the DER devices i.e., only open, industry standard protocols shall be accepted for the interfaces.

3.9 Remote Engineering Access

Should the DER solution require remote engineering access (REA) either from the utility or a third party, the solution shall comply with the requirements stipulated in this section.

3.9.1 The system shall support a detailed, low-level data and information view of each component / device (e.g., inverter, BESS, control units, etc.) in the system. This level should expose all possible data from, and send settings and controls to, the equipment / devices.

3.9.2 No internet connection shall inherently be required to enable any functionality detailed in this section.

3.9.3 The REA system will eliminate any direct access needed to any equipment to monitor, affect setting changes, or perform controls.

3.9.4 Remote engineering access which may include data retrieval and configuration shall be provided for

the following systems/devices which include but is not limited to:

a) Fire Detection and Suppression

b) NVR

c) VMS

d) Inverters

e) Battery Management System

f) Protection devices

g) SCADA Gateway

h) Generator System

3.9.5 As required, Modbus RTU/Serial ports shall be encapsulated within TCP/IP utilising Serial Device/Port Servers and directly made available to the REA system.

3.9.6 Should this Remote Engineering Access (REA) solution include the use of network devices (switches/routers/serial port servers) as well as telecommunications modems/routers, Eskom standardised equipment shall be used in the solution. Any proposed alternative for a 'more cost effective/optimised solution' must be accompanied by a comprehensive, fully-costed engineering justification and cyber-security assessment, and must receive explicit written approval.

3.9.7 Third party remote access shall comply with the requirements of [83] 32-373 Information Security – IT/OT and Third Party Remote Access Standard.

3.10 Physical Security Systems

The system shall comply with the following standards where applicable in support of the threat-and-risk assessment (performed by Eskom on request) of the site:

a) [14] 240-91190304 Specification for CCTV Surveillance with Intruder Detections.

b) [9] 240-76368574 High Security Mesh Fencing Standard.

c) [15] 240-102220945 Specification for Integrated Access Control System (IACS) For Eskom Sites

d) [12] 240-78980848 Specification for Nonlethal Energized Perimeter Detection System (NLEPDS) for Protection of Eskom Installations and Its Subsidiaries.

3.11 Data Logger / Historian

3.11.1 The DER solution shall support a local data logger or historian capable of securely recording key operational data as listed in Table 1:

Table 1 - Data Logger

Size Category [85]	Logging Frequency	Min. Retention	Key Data Points Required
A1 (0 – 13.8 kVA)	15 minutes (Aggregated/Averaged)	6 months	Production (kWh daily/monthly), inverter status, total energy export/import (from utility meter).
A2 (13.8 – 100 kVA)	5 minutes (Aggregated/Averaged)	1 year	Active Power (kW), Reactive Power (kVAr), Voltage, Frequency, Alarms/Events.
A3 (100 kVA to 1 MVA)	1 minute (or 5 seconds for high-frequency analysis)	1 year	All data from A1 and A2, plus: State of Charge (for BESS), real-time set-points. High-resolution waveform capture triggered by fault (if required by Eskom).

3.11.2 The local data logger / historian shall support the logging of supplementary data, on a per-project

basis if required. This may include:

a) Equipment performance data, e.g. internal temperatures.

b) Alarms and events

c) System load/consumption and production

d) Commands received & executed

e) Configuration data

f) Maintenance/Asset health data

g) Environmental data (weather, temperature, humidity, etc)

3.11.3 A data logger export facility shall be available, supporting data in the following tabulated fields (or similar):

a) Time-stamp – the date and time when the entry was captured

b) Tag Name – the name of the sensor or measurement

c) Value – the value of the measurement

d) Quality – an indication of the data quality

e) Comment/Annotation (if supported)

3.11.4 The DER solution shall support sending data to the utility's designated off-site/centralised Historian, as described in [84] 240-64038621.

3.12 Metering & Load Management

3.12.1 Metering shall be installed to record the total (bulk) usage of the customers supplied by the Microgrid source and for each individual customer. A smart metering solution shall be installed.

3.12.2 Bulk metering

a) A meter shall be installed to monitor the total consumption of the downstream customers supplied by the Microgrid source.

b) A data concentrator shall be installed to record the usage of the smart meters at the individual customers and to provide the required load management functionality.

c) The data concentrator shall be linked to the smart metering head end system (HES) via a suitable communication medium.

d) The meter and data concentrator shall be from Eskom's accepted list of metering equipment to ensure integration with the existing HES.

e) Both the bulk meter and the data concentrator shall be installed in an enclosure similar as specified in [34] D-DT-1047 for Microgrids smaller than 50kVA, [33] D-DT-1046 for 100kVA Microgrids and [28] D-DT-1023 for 200kVA CMG.

3.12.3 Customer metering

a) Smart meters compatible with the data concentrator shall be installed for each customer.

b) The smart meters shall be from Eskom's accepted list of metering equipment to ensure integration with the data concentrator and existing HES.

c) The smart meters shall be housed in pole top kiosks according to:

1) [29] D-DT-1042 for supplies to two customers

2) [30] D-DT-1043 for supplies to four customers

3) [31] D-DT-1044 for supplies to six customers

4) [32] D-DT-1045 for supplies to eight customers

5) Note that all Eskom standardised equipment that is currently on contract shall be used to fulfil this functionality.

3.12.4 Customer load management

a) The conditions stated in [6] 240-170000943, Microgrids Planning Standard, must be observed when implementing the load management in microgrids.

b) The smart meters shall be configured to provide load management according to the Table 2 below.

Table 2: Load management schedule

Summer		Winter		Stage	House limit [A]
Start time	End time	Start time	End time		
09:00	18:00	10:00	17:00	1	10
18:00	22:00	17:00	21:00	2	1
22:00	05:00	21:00	05:00	3	0.5
05:00	09:00	05:00	10:00	2	1

c) In addition to Table 2 above, emergency load limiting schedules may be applied on short notice when the generating capacity of the microgrid is constrained due to unforeseen weather conditions (e.g., rainy/cloudy day or week)

3.13 HVAC

Air conditioning systems shall comply with the requirements of [13] 240-82172806, Standard for Air Conditioning in Transmission Substation Buildings and Telecommunication Sites.

3.14 Fire Detection and Suppression System

If the outcomes from a rational design methodology, in accordance with best practices (e.g. NFPA or similar) indicates the need for a fire detection and suppression system, then compliance with the following standards are required:

a) [62] SANS 10139 Code of practice for design, installation, commissioning and maintenance of fire detection and alarm systems in non-domestic premises.

b) [64] SANS 14520 Gaseous Fire Extinguishing Systems – Physical Properties & System Design

c) [65] SANS 15779 Condensed Aerosol fire extinguishing systems – General Requirements

3.15 Telecommunications

The telecommunications technology solution for a DER will be dependent on various aspects as listed below:

a) The URS for the site solution,

b) Site location,

c) Nearby existing telecommunications infrastructure and,

d) Eskom approved technology solutions ensuring compliance to referenced standards:

1) [16] 240-132190480 Telecommunications Equipment Installation Standard

2) [17] 240-153473135 Installation of Telecommunications Equipment Cabinet

3) [18] 240-54615374 Distribution Substation Gateway Specification
4) [19] 240-103792430 Telecoms Cables and Various Materials Specification
5) [20] 240-95399670 Telecommunications Network Interface Converters Standard
6) [21] 240-75975613 Standard for the Installation of Power Telecommunication Equipment
7) [22] 240-72274830 Multimode Fibre Optic Duct Cable Specification
8) [23] 240-70783066 Telecommunications Transport Network Standard for TDM Circuits
9) [24] 240-70732888 Fibre Optic Cable System Acceptance Testing
10) [25] 240-48584707 Operational Technologies Over IP/MPLS
11) [26] 240-46264031 Fibre-Optic Design & Installations – Substations
12) [59] NRS 088-1 Duct and Direct Buried Underground Fibre Optic Cable Part 1: Product Specification
13) [60] NRS 088-2 Duct and Direct Buried Underground Fibre Optic Cable Part 2: Installation Guidelines
14) [58] NRS 081 Single-Mode Non-Dispersion Shifted Optical Fibres

3.16 Structural and other

3.16.1 Enclosure details

a) If shipping containers are used, they shall comply to these requirements:
   1) 40 foot (12.2 m), with maximum “cargo” weight 26460 kg
   2) 20 foot (6.1 m), with maximum “cargo” weight 28230 kg
b) Based on the scope, prefabricated enclosures shall comply with either:
   1) [86] 240-89498731, Equipment Container for AC-Powered Sites.
   2) [87] 240-171000459, Specification for BESS & Inverter Housing and Enclosure Structures
c) Corrosion protection shall be applied to the shipping container or any other metallic enclosure according to 240-75655504, for the applicable corrosivity category.

3.16.2 Enclosure foundation details

a) The following foundation shall be used for the container installations:
   1) 40 foot container: [39] D-DT-5282 sheets 1A and 1B or 1C and 1D depending on the soil conditions,
   2) 20 foot container: [39] D-DT-5282 sheets 1A or 1C depending on the soil conditions.
b) Any foundations required, not otherwise provided herein, shall comply with 3.16.3.1 (e.g. for prefabricated containers)
c) The container shall be earthed as indicated in drawing [35] D-DT-4407 sheet 1D.

3.16.3 Photovoltaic Support Structures

a) All support structures shall comply to the requirements listed in this section, irrespective if rigid or flexible PV panels are used.

b) The support structure shall be earthed as indicated in drawing [35] D-DT-4407 sheet 1D.

3.16.3.1 **Structure foundations technical requirements**

a) The structure foundations shall depend on site soil classification. The following soil classifications are applicable:

1) Type ‘1’ soils: competent soil with equal or better consistency (strength or toughness) than one would encounter in stiff cohesive soils or dense cohesionless soils above the water table. This soil must have a broad balanced texture (constituent particle sizes) with high average combinations of undrained shear strength and internal angle of friction, with minimum values of 80 kN/m^2 and 30° respectively. The minimum natural specific weight shall not be less than 17 kN/m^3.

2) Type ‘2’ soils: a less competent soil than type "1", with equal or weaker consistency than one would encounter in firm to stiff swelling cohesive soils, or dry poorly graded loose to medium dense cohesionless soils above the water table. The minimum undrained shear strength shall be 40 kN/m^2, and the minimum natural specific weight shall not be less than 15.5 kN/m^3.

3) Type ‘3’ soils: dry loose cohesionless soil or very soft to soft cohesive soil.

4) Type ‘4’ soils: submerged cohesionless and cohesive soils. This includes all soils below the permanent water table, including soils below a re-occurring perched water table, or permeable soils in low-lying areas subjected to confirmed seasonal flooding.

b) Depending on the prevailing soil type, the geotechnical design parameters as per Table 3 below shall be applied when designing foundations.

Table 3: Geotechnical design parameters

Parameter	Types ‘1’ & ‘2’ soils	Type ‘3’ soil	Type ‘4’ soil
Allowable soil bearing pressure	150kPa	100kPa	50kPa
Allowable toe bearing pressure	200kPa	125kPa	65kPa
Undrained shear strength	40kN/m^2	–	–
Minimum dry Density	1550kg/m^3	1400kg/m^3	1000kg/m^3
Density of reinforced concrete	2400kg/m^3	2400kg/m^3	1400kg/m^3

3.16.3.2 **Structure technical requirements**

The methodology defined in [63] SANS 10160-3 shall be used for all support structure designs, making use of the following standard parameters:

a) Design gust speed for a 50-year return period of 50m/s,

b) Design working life of at least 25 years,

c) Use terrain category A and D and see which one will provide the worst load case, which should then be used,

d) Altitude 0m.

3.16.3.3 **Structure direct lightning stroke protection**

a) As a minimum LPL II direct lightning stroke protection in accordance with [77] SANS 62305 shall be provided for.

b) The air termination system dimensions shall be determined by making use of the rolling spere method.

3.16.3.4 Structure mechanical standards

All structural steel, nuts and bolts shall comply to the standards indicated in Table 4:

Table 4: Mechanical standards

#	Item	Standard
1	All steel items, listed below, shall comply to the DX corrosion protection specification.	240-75655504 SANS 121
1.1	Square tube	SANS 657
1.2	Lip channel	Cold formed
1.3	Angle iron	Mild steel
1.4	Flatbar	Mild steel
1.5	Round Tube	SANS 657
1.6	Butterfly hinge	Mild steel
1.7	Drop side hinge	Mild steel
1.8	Galvanized Bolts and Nuts	240-75655504

3.16.3.5 Site layout considerations

a) Site clearance and grubbing operations shall be carried out in accordance with [69] SANS 1200 C.

b) The contractor to identify and expose, where relevant, all existing underground services on site and necessary mitigating actions to be taken.

c) Site to be prepared as per civil engineer's instruction before any earthworks are undertaken.

d) All earthworks to be carried out in accordance with [70] SANS 1200 DA.

e) All unsuitable materials must be removed and disposed of, then import G5/6 material if required.

f) All approved material to be stockpiled separately and later be reused as per civil engineer's instruction.

g) The contractor shall timeously submit field and laboratory test results of relative compaction densities as required to the civil engineer.

h) Unless otherwise instructed the standard 2.4m palisade fence with either 2x2.5m swing gates or 5m sliding gate as per [36] D-DT-5237 sheets 7 A-I shall be installed.

i) The fence centre line shall be at least 2m from any other infrastructure, measured horizontally.

j) The kerb shall be installed on the outside of the fence, not more than 0.2m from the fence, in accordance with [38] D-DT-5254.

k) All container foundations must have the same top level.

l) All PV structure foundations must have the same top level.

m) PV support structures shall be earthed through the foundations as indicated on [37] D-DT-5240 sheet 6, refer to [35] D-DT-4407 sheet 1D.

n) The whole kerbed area shall be covered 100mm thick with 26mm - 38mm crushed stone ([3] 240-108982466) after the earth grid and earth tails have been installed and after herbicide has been applied.

4. Authorisation

This document has been seen and accepted by:

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5. Revisions

Date	Rev	Compiler	Remarks
May 2024	1	T Jacobs	Original issue
November 2025	2	M Soni	Revised based on business requirements

6. Development team

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Not applicable.